James Hall's (1856) Rostroconchs from the Mississippian of Indiana and Illinois[1]

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ABSTRACT. Hall (1856) described without illustrations six species of the rostroconch *Conocardium* in his study of the fauna of the Salem Limestone in Indiana and the Warsaw Shale in Illinois. The species represent five genera, two of which are new, *Leptoconocardium* and *Kyoconocardium*. Other species represent the genera *Hippocardia* Brown, 1843; *Oxyprora* Hoare, Mapes, and Yancey, 2002; and *Diedrorynchus* Hoare and Peck, 2005.

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INTRODUCTION

In a continuing study of Upper Paleozoic rostroconchs it was thought useful to locate and examine the Mississippian (Meremecian) specimens described by Hall (1856) from the Salem Limestone in Indiana and the Warsaw Shale in Illinois. This study would compliment those made from the Mississippian in Ohio (Hyde 1953; Hoare 1990, 2004) and West Virginia (Hoare and Peck 2005). The purposes of this study are: 1) to redescribe and photographically illustrate Hall's specimens; 2) to update their taxonomic assignment; and 3) to relate the rostroconch occurrences to the lithology of the containing matrix.

PREVIOUS WORK

In 1856 Hall described, but did not illustrate, six Mississippian species of rostroconchs from the Salem Limestone in Indiana and the Warsaw Shale in Illinois. These included *Conocardium catastomum*, *C. carinatum*, *C. cuneatum*, and *C. equilaterale* from Indiana, and *C. prattenanum* and *C. meekanum* from Illinois. Whitfield (1882) republished Hall's descriptions and provided cartoon sketches of five of the species, not being able to locate the specimen of *C. equilaterale*. Hall (1883) republished on the species using Whitfield's illustrations. Beede (1906), quoting both Hall and Whitfield, republished Whitfield's illustrations and continued to be unable to locate the specimen of *C. equilaterale*. Branson (1942) provided a new specific name for *C. cuneatum, C. conalatum*, the former being preoccupied by Roemer (1850).

MATERIALS AND METHODS

Hall's 61 specimens are in the collections of the American Museum of Natural History (AMNH). In examining the specimens one was found which is believed to be the "missing" specimen of *C. equilaterale* and is illustrated herein (Fig. 1.17-1.19).

The shapes of the specimens are undistorted. The rostrum is partially or completely missing on all of the specimens and several have portions of the snout broken off. Weathering and/or removal from the matrix have reduced the outer shell layer so that fine ornamentation is often obliterated or poorly preserved. The ornamentation may not show up when the specimens are coated for photography, but is visible when uncoated or when slightly wet. Many of the fossils in the Salem Limestone are coated with a banded, oolitic-like coating which may hide the ornamentation. Remnants of the larval shell are present on some specimens.

All of the specimens are small, ranging in length from 2.3 mm to 12.0 mm. It is not believed that the specimens are immature forms representing species that reach larger sizes. Size-wise the specimens compare with the small genera found in the Pennsylvanian (for example, *Pseudobigalea* Hoare, Mapes, and Brown, 1982; *Baiosoma* Hoare, Steinker, and Mapes, 1988; *Hadropipetta* Hoare, Steinker, and Mapes, 1985; *Exalloschema* Hoare, Mapes, and Brown, 1982; and *Oxyprora* Hoare, Mapes, and Yancey, 2002). Two of Hall's species are assigned to *Oxyprora* (one questionably) and a third to *Diedrorynchus* Hoare and Peck, 2005, a small Mississippian genus in the Bluefield Formation and Reynolds Limestone (Chesterian) in West Virginia.

All of the specimens represent types and, in two instances, a species is represented by a single specimen. Sectioning to determine shell layers and shell microstructure was not possible. Cleaning with fine needles was done except where it would affect the shell surface. Specimens were coated with magnesium oxide for photographic purposes. In making measurements, sizes were estimated in several instances when specimens were slightly incomplete.

STRATIGRAPHIC RELATIONSHIPS

The collection localities as given by Hall were not specific. The locality for the Salem Limestone in Indiana was given as Spergen Hill near the railroad station of Harristown a few miles southeast of Salem. Spergen Hill is located in the S $^1/_2$ sec. 24, T2N, R4E, Washington County, IN. The locality for the Warsaw Shale in Illinois was given as near Alton, IL. This locality is probably somewhere in the bank of the Mississippi River.

In Indiana the Valmeyeran Salem Limestone conformably overlies the Harrodsburg Member of the Ullin Limestone and is overlain by the St. Louis Limestone. Smith *in* Shaver and others (1970, p 154) stated that the

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FIGURE 1. 1-12, *Leptoconocardium catastomum*; 1-2, right lateral and ventral views, AMNH-F1 39206; 3-6, lectotype, left lateral, posterior, ventral, and dorsal views, AMNH-F1 39207; 7-9, right lateral, posterior, and ventral views, AMNH-F1 51276; 10-12, dorsal, ventral, and right lateral views, AMNH-F1 51278, Salem Limestone, × 8; 13-16, *Oxyprora prattenanum*; holotype, right lateral, posterior, ventral, and dorsal views, AMNH-F1 39214, Warsaw Shale, × 8; 17-19, *Oxyprora? equilaterale*; holotype, right lateral, posterior and ventral views, AMNH-F1 51280, Salem Limestone, × 10; 20-28, *Hippocardia carinatum*; 20, posterior view, AMNH-F1 39209; 21-24, lectotype, ventral, right lateral, dorsal, and posterior views, AMNH-F1 39210; 25-26, posterior and right lateral views, AMNH-F1 51288; 27-28, right lateral and ventral views, AMNH-F1 51289, Salem Limestone, × 8.

Salem Limestone is composed of three lithologies including massive calcarenites, bedded calcarenites, and impure carbonate rocks. Fossils occur throughout the formation as complete and fragmental specimens which are sorted (Smith 1962).

In the outcrop area of the Valmeyeran Warsaw Shale in southwestern Illinois the formation consists of less than 100 ft of gray shale containing beds of argillaceous limestone and is fossiliferous (Atherton and others 1975). The Warsaw Shale is overlain by the Ullin, Salem, or St. Louis limestones and overlies the Keokuk Limestone. Lineback (1966) stated that the Warsaw Shale is equivalent to the Borden Siltstone, a deltaic deposit lying below the Ullin Limestone and above the Burlington Limestone.

Ohio Mississippian occurrences are from the Osagian Cuyahoga and Logan formations and the Chesterian Maxville Limestone (Hyde 1953; Hoare 1990, 2004). The Cuyahoga and Logan formations are near-shore deposits ranging from massive coarse-grained sandstone, argillaceous fine-grained sandstones, to interbedded shales and sandstones (Hyde 1953; Bork and Malcuit 1979). Rostroconchs found in these units include *Hippocardia herricki* Hoare, 1990, *Hippocardia* sp., *Aphalakardia alternistriata* (Herrick 1888), *Pseudomulceodens cancellatus* (Hyde 1953), and *Conocardium*? sp.

The Maxville Limestone overlies the Logan Formation and is composed of massive dolomitic limestone, thin- to thick-bedded argillaceous limestone, nodular limestone, and two thin shale units (see Hoare 2003, fig. 2). The rostroconchs *Bransonia hydei* Hoare, 1990 and *Oxyprora* sp. were found in the nodular limestone.

The West Virginia occurrences are in the Chesterian Bluefield Formation and Reynolds Limestone. The Bluefield is composed of "nearshore sands and muds with brief marine transgressions" (England and others 1979). The lower portion of the Reynolds consists of alternating thin beds of limestone and calcareous shales, evidence of a near shore area with oscillating sea level (Busanus 1974) and is interpreted as a restricted marine shelf (Carr and others 1966). *Diedrorynchus dictyum* Hoare and Peck, 2005 is the only rostroconch known from these units.

RESULTS

In updating the taxonomic classification the following changes have been made:

Conocardium catastomum Hall = *Leptoconocardium catastomum* (Hall)
C. prattenanum Hall = *Oxyprora prattenanum* (Hall)
C. equilaterale Hall = *Oxyprora? equilaterale* (Hall)
C. carinatum Hall = *Hippocardia carinatum* (Hall)
C. meekanum Hall = *Kyoconocardium meekanum* (Hall)
C. cuneatum Hall = *Diedrorynchus conalatum* (Branson)

The Salem-Warsaw species are younger than those from the Waverly Group in Ohio and older than those in the Maxville Limestone in Ohio and the Bluefield Formation and Reynolds Limestone in West Virginia.

The rostroconch occurrences range from arenaceous-argillaceous nearshore subtidal deposits to open carbonate platform deposits. None of the specimens were found in life position (semi infaunal) and had been moved and probably sorted to some extent by current action.

SYSTEMATIC PALAEONTOLOGY

Class Rostroconchia Pojeta, Runnegar, Morris, and Newell, 1972
Order Conocardiida Neumayr 1891; emend Amler and Rogalla, 2004
Superfamily Conocardioides Miller, 1889
Family Conocardiidae Miller, 1889
Genus *Leptoconocardium* n. gen.

Type species

Conocardium catastomum Hall, 1856.

Diagnosis

Small (4-5 mm long), elongate with snout distinct from body; anterior gape limited to anterior end of snout; dorsal margin of snout convex; costae on snout curve strongly to ventral margin.

Description

As for the species.

Etymology

Greek, *leptos*, small, fine, *conocardium*, cone shell.

Occurrence

Known only from the Mississippian (Valmeyeran) in Indiana.

Discussion

Leptoconocardium differs from *Conocardium* Bronn, 1835 by a shorter body and more distinct separation of body and snout, the ventrally curved snout costae, and the convex shape of the snout dorsally. *Arceodomus* Pojeta and Runnegar, 1976, besides being much larger, differs in having comarginal ridges on the body and rostral face and a straight dorsal margin.

Leptoconocardium catastomum (Hall 1856)
(Fig. 1.1-1.12)

Conocardium catastomum Hall, 1856, p 13; Whitfield 1882, p 58, pl. 7, figs.15-17a; Hall 1883, p 39, pl. 30, figs. 15-17a; Beede 1906, p 1325, pl. 23, figs. 15-17a.

Diagnosis

As for the genus.

Description

Very small, elongate, snout distinctly set-off from body; body somewhat swollen; lateral margins of snout subparallel in dorsal view, dorsal margin of snout convex in lateral view; rostral face oval, flatly convex, forming blunt ridge at valve juncture ventral to rostrum; rostum subcircular in cross section, length unknown; rostral clefts present; ventral orifice small, circular; beaks opisthogyrate; anterior gape restricted to anterior portion of snout, oval in shape, margin denticulate; 5-6 concentric costae on rostral face; 7-8 body costae; primary carina low, flat, same size as adjacent body costae; 8-9 narrow costae on snout, more widely-spaced anteriorly, curve sharply ventrally to margin of snout; fine, closely-spaced, comarginal lirae present, most prominent on snout; remnants of larval shell present.

Measurements

See Table 1.

Types

Lectotype, AMNH-F1 39207; paralectotypes, AMNH-F1 7651, 39206, 51276-51279.

TABLE 1

Measurements (in mm) of Leptoconocardium catastomum *(Hall).*

AMNH-F1	Length	Height	Width
39206	4.9	2.7	2.2
39207*	4.8	2.7	2.4
51276	4.7	3.0	2.7
51277	4.3	2.0	1.9
51278	3.9	1.8	1.7
51279	5.6	2.9	2.5

Occurrence

Salem Limestone (Valmeyeran) in Indiana.

Discussion

Monotypic *Leptoconocardium catastomum* is the most abundant species in the collection, 29 specimens. Whitfield's (1882) illustrations (pl. 7, figs. 15-16) appear to be of AMNH F1 39206 and (pl. 7, figs. 17-17a) being of AMNH F1 39207.

Genus *Oxyprora* Hoare, Mapes, and Yancey, 2002

Type species

Conocardium parrishi Worthen, 1890.
Oxyprora prattenanum (*Hall 1856*)
(Fig. 1.13-1.16)

Conocardium prattenanum Hall, 1856, p 15; Whitfield 1882, p 61, pl. 7, fig. 20; Hall 1883, p 346, pl. 30, fig. 20.

Conocardium perattenanum (*sic*) Hall; Beede 1906, p 1328, pl. 23, fig. 20.

Description

Small with strongly-produced, prow-shaped, rostral face; dorsal margin straight; beaks opisthogyrate; snout set-off from body laterally by distinct change in slope; body not swollen; anterior gape large, wide, narrowing posteriorly, slightly expanded at anterior end, denticles apparently absent; rostral face with six coarse, concentric, intercalated costae; ventral orifice small, circular; primary carina rounded, similar in size to adjacent rostral face costa; body with 9 smaller, narrow, widely-spaced costae, some of which are intercalated; snout with 5 closely-spaced costae, partially intercalated, larger than body costae; prominent, fine, comarginal, growth crenulations on body, snout, and rostral face; larval shell not present.

Measurements

Length, 4.5 mm; height, 3.7 mm; width, 3.3 mm.

Type

Holotype, AMNH F1 39214.

Occurrence

Warsaw Shale (Valmeyeran) near Alton, IL.

Discussion

Oxyprora prattenanum differs from the Pennsylvanian *O. parrishi* (Worthen 1890) by having fewer and coarser costae on the rostral face and coarser costae on the snout. *Oxyprora missouriensis* (Girty 1915), also from the Pennsylvanian, has a reticulate network of comarginal lirae and fine costae on the body and snout and a larger primary carina than is present on *O. prattenanum. Oxyprora pulchellum* (White and Whitfield 1862), from the Osagian Burlington Limestone, is preserved as a partial right valve. It is similar to *O. prattenanum* in general but differs in having seven concentric costae on the rostral face, fewer and larger body costae, a stronger primary carina, and less produced rostral face. The holotype of *O. pulchellum* is in the University of California, Berkley Museum of Paleontology, no. 1119/3246, not the specimen figured by Weller (1901, pl. 17, figs. 2-3). *Oxyprora* sp. Hoare, 2004, from the Maxville Limestone (Chesterian) in Ohio, is represented by poorly preserved specimens which differ from *O. prattenanum* by being more elongate and having a rostrum angled dorsally. *Oxyprora mesialis* (Weller 1916), from the Valmeyeran Ste. Genevieve Limestone in Illinois, has a stronger primary carina, larger body costae, and less produced rostral face than *O. prattenanum. Oxyprora sayrei* (Elias 1957), from the Mississippian Redoak Hollow Formation in Oklahoma, is more elongate, has a more strongly produced rostral face, has fewer body and snout costae, and stronger comarginal lirae forming a reticulate pattern. *Oxyprora irregulare* (Koninck 1842), from the Lower Carboniferous of Belgium and from the Lower Carboniferous of the United Kingdom (Hind 1900), is similar to *O. sayeri* in shape but has a more subdued costation and network pattern.

Oxyprora? equilaterale (Hall 1856)
(Fig. 1.17-1.19)

Conocardium equilaterale Hall, 1856, p 16; Whitfield 1882, p 62; Hall 1883, p 348; Beede 1906, p 1329.

Description

Very small, incomplete shell with sharply produced rostral face; dorsal margin straight; body narrowly convex in dorsal view; beaks opisthogyrate; most of snout missing; anterior gape not preserved; six concentric, low costae on rostral face, rostrum missing; dorsal clefts present; primary carina becomes larger ventrally, otherwise approximately same size as 8 larger body costae; smaller body costae intercalated between larger costae posteriorly; 6 costae on posterior portion of snout; partial larval shell present.

Measurements

Length, 2.3 mm; height, 2.3 mm; width, 1.8 mm.

Type

Holotype, AMNH-F1 51280.

Occurrence

Salem Limestone (Valmeyeran) in Indiana.

Discussion

The specimen described above was found by the curator of the AMNH contained within the sample container with *Oxyprora prattenanum.* Only one specimen of *O. prattenanum* was mentioned by Hall (1856) to be in the collection and only one specimen of *C. equilaterale* formed the basis for Hall's description. On the basis of

the size, shape, ornamentation, and incompleteness, the specimen matches Hall's description exactly. Whitfield (1882) believed the specimen had become lost, as did Beede (1906). Evidently, the specimen had been misplaced at some time and when found was placed in with the specimen of *O. prattenanum*. Because both species have a produced rostral face they were thought to represent the same species. *Oxyprora? equilaterale* differs from *O. prattenanum* by having finer costae on the rostral face and a narrower body. The missing anterior portion of the snout precludes a comparison with the larger costae on that portion of the shell and the shape of the anterior gape of *O. prattenanum* and leads to a questionable generic assignment.

Family Hippocardiidae Pojeta and Runnegar, 1976
Genus *Hippocardia* Brown, 1843

Type species

Cardium hibernicum Sowerby, 1815.
Hippocardia carinatum (Hall 1856)
(Fig. 1.20-1.28)

Conocardium carinatum Hall, 1856, p 14; Whitfield 1882, p 59, pl. 7, figs. 18-19; Hall 1883, p 345, pl. 30, figs. 8-19; Beede 1906, p 1326, pl. 23, figs. 18-19.

Description

Small, truncate posteriorly; dorsal margin straight; body not inflated, separated from snout by change in concavity; beaks opisthogyrate; primary carina smooth, narrow, alate laterally and ventrally forming a short hood; anterior gape widest anteriorly, extending length of snout as narrow, triangular opening; gape bordered by moderately large denticles; 11 low, closely-spaced, concentric costae on rostral face, area around base of rostrum smooth; length of rostrum unknown; rostral clefts present; ventral orifice small; 7 narrow, widely-spaced body costae bifurcate ventrally; 12-13 costae on snout, more closely-spaced anteriorly; outer shell layer thin with numerous fine, closely-spaced, comarginal lirae, most prominent on snout; larval shell not present.

Measurements

See Table 2.

Types

Lectotype, AMNH-F1 39210; paralectotypes, AMNH-F1 7650, 39208, 39209, 51288, 51289.

Occurrence

Salem Limestone (Valmeyeran) in Indiana.

Discussion

The narrow, short hood readily distinguishes *H. carinatum* from the other species found in the Salem and Warsaw units. Some of the small Pennsylvanian taxa [for example, *Pseudobigalea crista* Hoare, Mapes, and Brown, 1982 and *Baisoma pala* (Hoare, Steinker, and Mapes 1988)] have small, short hoods but differ in shape, costation patterns, and ornamentation of the outer shell layer. The rounded protuberance in Fig. 1.22-1.24 is an endothyroid foraminifera stuck into the broken off rostral opening. Whitfield's (1882) illustrations (pl. 7, figs. 18, 19) appear to be of AMNH-F1 39208.

Family Bransoniidae Pojeta and Runnegar, 1976
Genus *Kyoconocardium* n. gen.

TABLE 2

Measurements (in mm) of Hippocardia carinatum *(Hall).*

AMNH-F1	Length	Height	Width
39208	6.9'	5.3	5.3
39210*	6.9	6.0	5.6'
51288	6.5'	4.8'	4.6'
51289	6.4	5.6	5.0

*lectotype; 'estimated

Type species

Conocardium meekanum Hall, 1856.

Diagnosis

Body swollen; rostral face produced, primary carina lacking.

Description

As for the species.

Etymology

Greek, *kyo*, swell, anything swollen, *conocardium*, cone shell.

Occurrence

Mississippian (Valmeyeran) in Illinois.

Discussion

Kyoconocardium differs from *Apotocardium* Hoare, Mapes, and Yancey, 2002 by the lack of a primary carina, a produced rostral face, and more distinct separation of body and snout. *Pseudomulceodens* Hoare 1990 has longitudinal shelves in the snout, a longer anterior gape, and a truncate rostral face. *Bransonia* Pojeta and Runnegar, 1976 is truncate posteriorly. *Oxyprora* Hoare, Mapes, and Yancey, 2002 has a more extended rostral face with fewer and larger costae on it.

Kyoconocardium meekanum (Hall 1856)
(Fig. 2.1-2.9)

Conocardium meekanum Hall, 1856, p 15; Whitfield 1882, p 61, pl. 7, figs. 21-23; Hall 1883, p 347, pl. 30, figs. 21-23; Beede 1906, p 1328, pl. 23, figs. 21-23; Branson 1958, figs. 7-8.

Diagnosis

As for the genus.

Description

Small with inflated body; dorsal margin straight in lateral view; beaks opisthogyrate; rostral face convex, slightly protruding; body separated from snout by broad sulcus; anterior gape large, V-shaped, extending length of snout, may extend into body slightly; margin of gape with short denticles; primary carina lacking; posterior edge of body, bearing two costae forming a subdued carina, rounds sharply to meet rostral face at a marked juncture; rostral clefts present; 13-14 narrow, widely spaced body costae; 18 costae on snout, alternating large and small posteriorly, becoming more widely-spaced and of even size anteriorly; 8 or more low, narrow, widely spaced, concentric costae on rostral face;

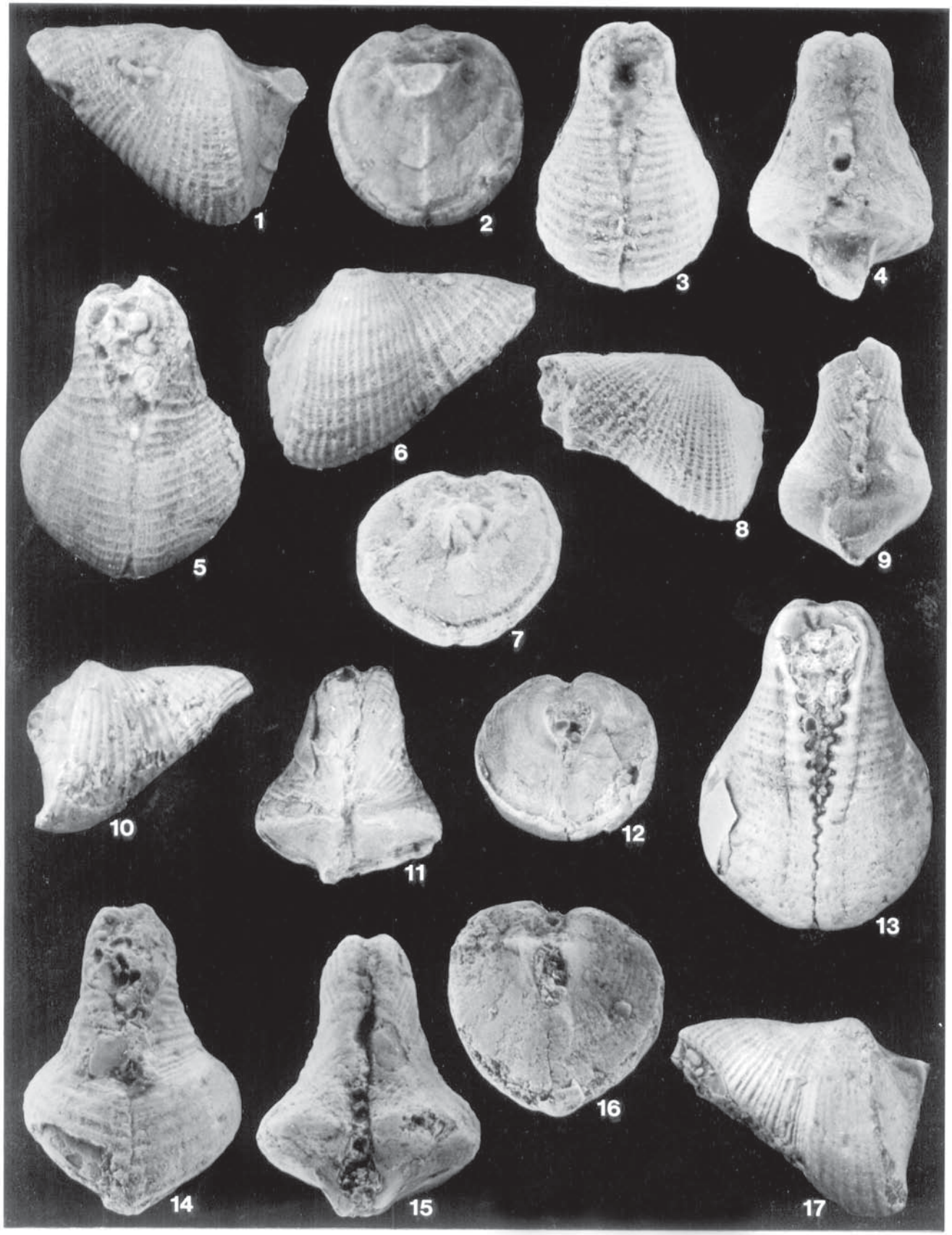

FIGURE 2. 1-9, *Kyoconocardium meekanum*; 1-4, lectotype, right lateral, posterior, ventral, and dorsal views, AMNH-F1 39216; 5-7, ventral, right lateral, and posterior views, AMNH-F1 39215; 8-9, right lateral and dorsal views, AMNH-F1 51284, Warsaw Shale, × 8; 10-17, *Diedrorynchus conalatum*; 10-12, lectotype, right lateral, dorsal, and posterior views, AMNH-F1 39212; 13, ventral view, AMNH-F1 39211; 14-17, ventral, dorsal, posterior, and right lateral views, AMNH-F1 51281, Salem Limestone, × 5.

numerous fine, comarginal lirae and several growth crenulations present; partial larval shell preserved.

Measurements

See Table 3.

Types

Lectotype, AMNH-F1 39216; paralectotypes, AMNH-F1 39217, 39215, 51284-51287.

Occurrence

Warsaw Shale (Valmeyeran) near Alton, IL.

Discussion

The subdued primary carina, the shape of the posterior edge of the body meeting the rostral face, the costation pattern, and the swollen body are distinguishing characteristics of *K. meekanum*. '*Conocardium*' *spinalatum* Rowley, 1900, from the Osagian Burlington Limestone in Missouri, does not have an inflated body and has a much more distinct separation of body and snout. Whitfield's (1882) illustrations (pl. 7, figs. 21-23) appear to be of AMNH-F1 39216.

Genus *Diedrorynchus* Hoare and Peck, 2005

Type species

Diedrorynchus dictyum Hoare and Peck, 2005

Diedrorynchus conalatum (Branson 1942)
(Fig. 2.10-2.17)

Conocardium cuneatum Hall, 1856, p 14 (*non* Roemer 1850); Whitfield 1882, p 60, pl. 7, figs. 24-26; Hall 1883, p 345, pl. 30, figs. 24-26; Beede 1906, p 1327, pl. 23, figs. 24-26.
Conocardium conalatum Branson, 1942, p 388.
Pseudoconocardium conalatum (Branson); Hoare 1990, fig. 3.21.

Description

Small bransoniid-like shell with non-inflated body; snout tapering slightly in dorsal view, separated from body by broad concavity; dorsal margin convex in lateral view; rostral face subcircular, concave laterally around rostrum; beaks opisthogyrate; rostral clefts present; ventral orifice small; anterior gape large, extending length of snout, slight constriction near anterior end, denticles short; large, rounded primary carina; 7-8 rounded, closely spaced, body costae; 13-14 narrower, more widely spaced costae on snout; 14 low, narrow, closely-spaced, concentric costae on rostral face; rostrum smooth; fine, closely spaced, comarginal lirae and coarse growth lines present; larval shell not preserved.

Measurements

See Table 4.

TABLE 3

Measurements (in mm) of Kyoconocardium meekanum *(Hall).*

AMNH-F1	Length	Height	Width
39215	6.9	4.6	4.5
39216*	6.4	4.8	4.5
51284	6.8	5.5	5.4
51285	7.6	5.1	5.2
51286	6.2	4.0	3.5
51287	5.9'	4.2	3.7

*lectotype; 'estimated

TABLE 4

Measurements (in mm) of Diedrorynchus conalatum *(Branson).*

AMNH-F1	Length	Height	Width
39211	12.3	7.0'	9.7
39212*	8.5	6.5	6.9
51281	10.5	7.8	7.3
51282	9.8	5.7	6.2
51283	8.6	6.0'	6.6

*lectotype; 'estimated

Types

Lectotype, AMNH-F1 39212; paralectoypes, AMNH-F1 39211, 39213, 51281-51283.

Occurrence

Salem Limestone (Valmeyeran) in Indiana.

Discussion

Diedrorynchus conalatum differs from *D. dictyum* Hoare and Peck, 2005, from the Chesterian Hinton Formation in West Virginia, by a non-swollen body, less distinct separation of body and snout, less constriction of the anterior portion of the anterior gape, and less distinction between sizes of costae on the body and snout. Whitfield's (1882) illustrations (pl. 7, figs. 24-25) appear to be of AMNH-F1 39212 and of (pl. 7, fig. 26) being of AMNH-F1 39211.

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